characterizes the classical approach in computational fluid dynamics for multiphase flow simulation. This book presents important fundamental and applied aspects of multiphase flow and fluidization. The uniqueness of the book, however, lies in that it is the first one including the modeling approach based on the kinetic theory of gases to describe the particulate-phase transport properties such as solid-phase viscosity and pressure, in simulating fluid-particle flows.

An analogy between particle collision in suspensions and molecules in the kinetic theory of gases was suggested as early as the 1960s. However, this approach, which rigorously follows the kinetic theories of gases for solid particles, came to a halt due to the complexity surrounding the direct application of the Boltzmann equation accounting for interparticle collisions. The physical basis of the kinetic theory of gases is elastic collisions of monodispersed spheres with Maxwellian velocity distributions in an infinite vacuum space. As a result, the fluid-solids interactions involving velocity- and pressure-dependent forces, energy dissipation due to inelasticity and friction in particle collisions and particle-wall interactions, and nonuniformity in particle size are all excluded from the direct analog between solid particle interactions and molecular interactions. These constraints physically limit the practical use of the kinetic theory to granular flows where viscous effects can be neglected. An alternative approach using simplified kinetic theories of gases based on mechanistically derived or intuitive relationships in place of the Boltzmann equation is viewed viable by various researchers. This approach in various forms has been applied to many gas-solid flow systems including fluidization and pneumatic transport and has shown very encouraging results in predicting fluid-particle flow behavior which would otherwise be unpredictable with conventional approaches. Professor Gidaspow is a major contributor in this endeavor.

The book contains 12 chapters, some basic features of each chapter are outlined below. Chapter 1 presents basic equations for single-phase laminar flows and general formulation of multiphase flow equations. Chapter 2 applies the equations in Chapter 1 to one-dimensional studies of the pneumatic conveying of solids, focusing on vertical flow and its pressure drop. Chapter 3 describes the drift flux model which estimates the volume fractions of fully developed 1-D multiphase flows. Chapter 4 on critical granular flows illustrates the governing equations for static packed powders and 1-D granular flows. Chapter 5 presents regimes and fundamental characteristics of fluidization including a kinetic energy dissipation analysis. Chapter 6 discusses modeling of bubble formations in fluidized beds and a bubbling criterion using the shock theory. Chapter 7 on the fundamental nature of bubbling fluidized beds describes classical bubbling bed models. The bulk of the chapter, however, covers the governing equations and computational results for various operating conditions and their comparisons with experimental results. Similar to Chapter 7, Chapter 8 presents fundamental characteristics of circulating fluidized beds. Chapters 9, 10 and 11 summarize the essential concepts of the kinetic theory of gases in the modeling of fluid-particle flows. Chapter 12 illustrates the phenomena of sedimentation and consolidation of solids in particulate flows, as well as an electrokinetic phenomenon (Zeta potential).

As noted, the book highlights the application of the kinetic theory of gases in fluid-particle flows, which are presented remarkably well in Chapters 9, 10 and 11. The kinetic theory of gases pertaining to the Maxwellian state, frequency of collisions, mean-free path, Boltzmann integral-differential equations, and others are comprehensibly introduced. The inherent similarity of transport properties between gaseous molecules and granular powders is thoroughly discussed. The applications of the kinetic theory to fluid-particle flow systems, such as circulating fluidized beds, are impressively demonstrated. There are places in the book, however, that could have been described somewhat differently. For example, in Chapter 2, the negative pressure drop could be explained mechanistically in terms of drag reduction phenomena contributed by various possible mechanisms including turbulence modulation of the phase rather than the "negative" friction of solids described in the chapter. In Chapter 7, Inviscid Multiphase Flows, the use of *inviscid* in the heading does not appear to be appropriate as the wake-induced vortex shedding and vortex dissipation in bubble flows introduced are all viscous-related. Some comments concerning the physical limitations of the kinetic theory application in fluid-particle flow and turbulent effects in multiphase flow would have been useful to readers. As the fundamental concepts are not very uniformly presented from first principles, instructors may need some supplementary materials when using this book as a textbook in the classroom. It is noted, however, that the homework exercise problems contain valuable information, which appreciably augments the scope of the text.

Overall, this book provides a unique and thorough review of the kinetic theory of gases in the modeling of fluid-particle flow and an impressive exposition of computational contributions by the author's research group at the Illinois Institute of Technology. The book is published at a time when predictive methodologies based on computational fluid dynamics for multiphase flow are urgently needed. Therefore, it is a welcome addition to the literature in this field. It would be an excellent addition to a collection to those who are interested in the applications of kinetic theory modeling and computation to fluidization systems. The book, however, may need to be supplemented with other materials to be effectively used as a textbook in multiphase flow.

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Flow and Transport in Porous Media and Fractured Rock

By Muhammad Sahimi, VCH-Verlagsgesellschaft mbH, Weinheim, Germany, 1995, 482 pp., $65.00.

The author reviews classic methods to modern approaches for flow and transport in porous media and fractured rock. The book concentrates on modeling the morphology of porous media and of fracture systems, which eventually leads to either statistical or discrete models for calculating various properties and flow phenomena in porous systems. Since molecular or microscopic flows collectively make up the macroscopic and megascopic flows, this approach is useful for understanding the mechanisms behind various flow phenomena and provides insight into how one might model macroscopic or megascopic situations. Overall, the book is well written, reasonably descriptive and understandable. A minor irritation —it would have been useful to have a list of symbols.

There is some research on calculating flow in porous media deterministically at the macroscopic level. Also, there is literature associated with homogeniza-

tion to model flow numerically in megascopic systems, including the multiple porosity situation that occurs in fractured systems. The author does not refer to this literature. He revisits percolation theory and fractal concepts continually.

The strength of this book is the inclusion of fractures—it is done very well. Its shortcoming, however, is a lack of discussion of experimental and field data, which are used only to compare with various models but not as information.

The first five chapters introduce concepts used throughout the remainder of the book, such as heterogeneity and length scales, Darcy's law, the use of fractals and percolation models, the diagenetic process, porosity, surface area, tortuosity and porosimetry.

Chapter 6 is a cursory discussion of models of porous media including the spatially periodic model, lattice models, and network models. The most interesting part is the review of pore surface roughness. Chapter 7 on the multiporosity models for fractures and fractured rock describes nicely network models for fractures in one, two and three dimensions. Chapter 8 presents a volume-averaged "derivation" of Darcy's law. This, however, is not a derivation; it simply shows that Darcy's law is consistent with the Stokes equation. Volume averaging depends on the porous media being spatially periodic. Natural porous media are aperiodic.

The discussion in Chapter 9 on dispersion in porous media is classic and includes percolation methods. The author points out that in megascopic systems the normal or classical techniques do not work. Evidence is clear that most natural systems are not spatially periodic or at least the length scales are so large that the period is not stationary. Chapter 10 on flow and dispersion in fractures is excellent. Chapter 11 on a cursory view of miscible displacement discusses Hele-Shaw models in length. Although this model is a two-dimensional analog of flow in porous media and provides some visual results that might occur in porous media, it does not offer a three-dimensional picture and may be misleading.

Chapter 12 discusses stability and contact angles and their measurement in immiscible systems. There is a discussion of how fractals describe this particular problem. The displacement of blobs and trapping is described well. Chapter 13 is interesting because it discusses flow and transport in unconsolidated porous media. Most authors have not made the distinction between consolidated and unconsolidated media as succinctly. Chapter 14 shows various ways of numerically modeling flow in porous media. Discussion of automata approaches in this chapter is merely a short literature review rather than an explanation.

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Conformational Theory of Large Molecules: The Rotational Isomeric State Model in Macromolecular Systems

By Wayne L. Mattice and Ulrich W. Suter, Wiley, New York, 1994, 449 pp. $54.95.

This book endeavors to bring up-to-date the large body of work which has grown up around the well-established rotational isomeric state (RIS) model of macromolecules. At first glance, it might seem passé in today's world of molecular simulation for handling complex and descriptive models to revitalize a model at the root of which is the fundamental approximation of discretizing the continuum of molecular conformational space into a finite (and for all practical purposes small) fraction of isolated states. As the authors correctly point out, however, the RIS model distinguishes itself as one that strikes a delicate balance between retention of chemical-level detail and a computationally tractable theoretical analysis for which the more complex molecular models have no parallel. The idea of the isomeric state model for molecular conformations is not new, dating back to Volkenstein's work in the 1950s, but the techniques that may be applied to it to extract important properties of polymers are powerful, and both the underlying statistical mechanical fundamentals of RIS theory and the application of these techniques have continued to improve since the publication 25 years ago of Paul Flory's classic text, *Statistical Mechanics of Chain Molecules*.

This book of 400+ pages attempts to serve the several goals of providing a self-instruction text for the novice as well as a reference text for the expert of generalizing the matrix formalism for rendering the model useful in macromolecular systems of almost arbitrary complexity and for a wide range of properties, and of providing a near-comprehensive compendium of works where the RIS model has found application to date. Clearly, it will have special appeal to those working with the physical chemistry of polymers, but the speed and ease of use of the methods described in this book should prove useful as well to other chemical engineers in product or process design and engineering who are willing to make the initial investment in model construction.

The book with 15 chapters is divided into four parts. The first two chapters present introductory material to put the RIS model in perspective relative to the panoply of models common in polymer science and experimental observables frequently addressed by RIS methods. The next four chapters follow a pedagogical development of the RIS model and the matrix techniques for computing the partition function and some basic geometric properties of simple chains. The third section, the largest portion of the book, details the important, and somewhat advanced, features of the matrix methods which allow for treatment of complex molecular architectures, ranging from treatment of tacticity and comonomers in polymers chains to dealing with stars, grafts, and other articulated structures. Interspersed within this section are a description of a hybrid technique which samples the conformation space of the RIS model to access quantities that do not lend themselves to the more direct matrix multiplication approach, and a treatment of helix-coil and sheet-coil transitions which is similar in form to the RIS model and avails itself of the same methods of analysis. The final three chapters demonstrate the utility of the RIS matrix formalism to treat other conformation-dependent properties, including tensorial quantities, approximate incorporation of excluded volume interactions, stereochemical equilibria, and time-dependent behavior. Each chapter concludes with something on the order of ten self-test problems to check comprehension; solutions to 72% of these are provided at the end of the book. A sample program is also provided.

Anyone familiar with the Flory's classic text will appreciate both the similarities and differences between the 1969 original and this update. In good Flory tradition, the authors have embedded in footnotes much useful and sometimes essential information regarding notations, conventions, and derivations in each chapter. Along the way, they take the time to point out and clarify some of the conflicting or confusing nomenclature which has arisen over the years in polymer statistical mechanics due to